IC5.3: Optional Job Sheet

The Effect of Stability on the Response to Internal Forcing in the Atmosphere

Objective: Demonstrate how to assess Equivalent Potential Vorticity (EPV) fields and their effect on winter weather precipitation through a case study.

Data: You will examine 2 different cases to show how EPV or lack of EPV affects the scale and magnitude of the precipitation. As with job sheets for IC 5 Lessons 1 and 2, you will first re-examine the 15 March 2004 winter storm event in the Midwest, then a contrasting event from 4 November 2003, also across the Midwest. You will be using your WES machine in case review mode.

Instructions:

Case #1
On your WES machine, load the 15 March 2004 case, DMX localization, and set the clock to 15 March 2004, 13:00 UTC. **Focus on the 12 UTC 15 March NAM 80 analysis for each question in this jobsheet, unless otherwise noted.**

Load surface metars and RUC or NAM40 surface potential temperature. Take a cross section northeast to southwest from southeast Minnesota to eastern Kansas, normal to the surface front across southern Iowa. Load NAM 80 wind vectors, and ageostrophic vertical circulation streamlines. Focus on the NAM analysis at 12 UTC 15 March 2004.

Question 1. Based on the shape of the circulation and pattern of the vertical motion streamlines, what would you infer about the static stability and inertial stability?

Now overlay geostrophic momentum and saturated equivalent potential temperature.

Question 2. Does this agree with model's assessment in #1 of the vertical circulation and thus the inertial and static stability? Why or why not?

Next, overlay Saturated EPV_g (MPV_g).

Question 3. How does this compare with what you saw with momentum surfaces and saturated equivalent potential temperature regarding static stability?

Question 4. Where is the strongest conditional or symmetric instability in this cross section? Is it deep?

Along the same cross section but in a different window, load NAM80 saturated equivaletn potential temperature, saturated equivalent geostrophic potential vorticity (MPV_g), and RH. Shade only the PV values less than +0.25 PV units. Focus on the NAM analysis valid 12 UTC 15 March 2004.

Question 5. What is the likely cause of the MPV_g minimum in the 700-300 mb layer across the southern end of the cross section?

Now overlay 2-D frontogenesis.

Question 6. Where is the smallest vertical separation between the maximum in frontogenesis and MPV_g minimum located?

Question 7. Where would the north and south extents of the heavy snow band likely occur? (Hint, examine the horizontal distance from the maximum frontogenesis at 600 mb to the northeast and at 900 mb to the southwest)

Based on your analysis of the NAM analysis valid 12 UTC 15 March 2004, load a plan view 2-D frontogensis near the level of maximum frontogenesis over Iowa, and overlay MPV_g and RH in the layer 100 mb above the front you discovered in the cross sections.

Question 8. Where, if anywhere, is the MPV_g minimized above the frontogenesis?

Question 9. Based on your answer in #8, where do you expect the heaviest snowfall to occur and what is the primary forcing mechanism in that region?

Now overlay Div-Fn vectors in the same layer you displayed MPV_g.

Question 10. How do the Fn convergence fields compare to the stability above the frontal zone? Is this surprising? Why/Why not?

Case #2—A different perspective

If you have extra time and want to examine a case with different stability and frontogenesis coupling, give this event a try. Load the 04 November 2003 case, FSD localization, and set the clock to 04 Nov 2003, 07:00 UTC. **Focus on the 06 UTC 04 November March NAM 80 analysis for each question in this jobsheet, unless otherwise noted.**

Determine the location of the surface front at 6 UTC on 4 November 2003. Take a cross section normal to the surface front across southern North Dakota to southeast Kansas (essentially normal to the thermal wind) and load NAM80 wind vectors, and ageostrophic vertical circulation streamlines. Focus on the NAM analysis at 06 UTC 04 November 2003.

Question 11. Based on the shape of the circulation and pattern of the vertical motion streamlines, what would you infer about the static stability and inertial stability?

Question 12. Now overlay geostrophic momentum and saturated equivalent potential temperature. Does this agree with model's assessment in #11 of the vertical circulation and thus the inertial and static stability? Why or why not?

Next, overlay MPV_g.

Question 13. How does this compare with what you saw with momentum surfaces and saturated equivalent potential temperature regarding static stability?

Question 14. Where is the strongest conditional or symmetric instability in this cross section? Is it deep?

Along the same cross section but in a different window, load NAM80 saturated equivalent potential temperature, MPV_g, and RH. Focus on the NAM analysis valid 06 UTC 04 November 2003.

Question 15. Where do you see the potential for deep convection to develop?

Now overlay 2-D frontogenesis.

Question 16. Where is the smallest vertical separation between the maximum in frontogenesis and MPV_g minimum located?

Question 17. Where would the north and south extents of the precipitation band likely occur?

Based on your analysis of the NAM analysis valid 06 UTC 04 November 2003, next load a plan view 2-D frontogensis near the level of maximum frontogenesis over southern Nebraska/central Kansas, and overlay MPV_g and RH in the layer 100-150 mb above the front you discovered in the cross sections.

Question 18. Where, if anywhere, is the MPV_g minimized above the frontogenesis?

Question 19. Based on your answer to #18, where do you expect the heaviest precipitation to occur and what is the primary forcing mechanism in that region?

Now overlay Div-Fn vectors in the same layer you displayed MPV_g.

Question 20. How do the Fn convergence fields compare to the stability above the frontal zone? Is this surprising? Why/Why not?

An answer key is available for this job sheet. Please see your local AWOC Winter Weather facilitator to obtain a copy.